

CLAIMS

What is claimed is:

- 1     1.     A method for creating a magnetic head, comprising:  
2             adding leads to a wafer stack having a free layer, a bias layer, and a spacer layer  
3                     between the free layer and bias layer, wherein a gap is formed between the  
4                     leads;  
5             adding a protective layer to the wafer stack such that the gap is covered, the  
6                     protective layer also covering facing ends of the leads;  
7             removing material from at least one side area of the wafer stack using the  
8                     protective layer as a mask;  
9             removing the protective layer; and  
10            processing a portion of the bias layer below the gap for reducing a magnetic  
11                     moment of the bias layer in the portion of the bias layer below the gap for  
12                     forming a sensor in which magnetic moments of end portions of the free  
13                     layer are pinned by magnetic moments of end portions of the bias layer.
  
- 1     2.     The method as recited in claim 1, wherein the magnetic moments of the end  
2             portions of the free layer are pinned antiparallel to the magnetic moments of the  
3             end portions of the bias layer.

- 1    3.    The method as recited in claim 1, wherein the leads are added to the wafer stack  
2            by an additive process.
- 1    4.    The method as recited in claim 1, wherein the gap is formed between the leads by  
2            reactive ion etching.
- 1    5.    The method as recited in claim 1, wherein the protective layer includes a resist  
2            undercoat and a second layer of resist above the resist undercoat.
- 1    6.    The method as recited in claim 5, further comprising applying a developer to the  
2            resist undercoat for removing a portion of the resist undercoat such that opposite  
3            ends of the resist undercoat along a plane parallel to an upper surface of the wafer  
4            stack are closer together than opposite ends of the second layer of resist.
- 1    7.    The method as recited in claim 1, wherein the material in the at least one side area  
2            of the wafer stack is removed by at least one of ion milling and sputter etching.
- 1    8.    The method as recited in claim 1, wherein an edge of the at least one side area of  
2            the wafer stack after removing the material is oriented at an acute angle relative to  
3            a line perpendicular to a plane parallel to an upper surface of the wafer stack.
- 1    9.    The method as recited in claim 1, wherein material is removed from both side  
2            areas of the wafer stack, wherein edges of the side areas of the wafer stack after

3 removing the material taper towards each other in a direction away from the wafer  
4 stack.

1 10. The method as recited in claim 1, wherein the protective layer is removed by a lift  
2 off process.

1 11. The method as recited in claim 1, further comprising adding lead material to the at  
2 least one side area of the wafer stack.

1 12. The method as recited in claim 1, wherein the magnetic moment of the bias layer  
2 is reduced by oxidation.

1 13. The method as recited in claim 1, wherein the magnetic moment of the bias layer  
2 is reduced by ion implantation.

1 14. The method as recited in claim 1, wherein the magnetic moment of the bias layer  
2 is reduced by milling.

1 15. The method as recited in claim 1, wherein the magnetic moment of the bias layer  
2 is reduced by at least one of self-aligned oxidation, self-aligned ion implantation  
3 and self-aligned milling.

1 16. A magnetic head formed by the process of claim 1.

1 17. The magnetic head as recited in claim 16, wherein end regions of the leads taper  
2 towards facing ends thereof.

1 18. The magnetic head as recited in claim 16, wherein the magnetic head has no hard  
2 bias elements.

1 19. The method as recited in claim 16, wherein a thickness of the bias layer in a  
2 direction perpendicular to a plane parallel to an upper surface of the wafer stack is  
3 less than a thickness of the free layer in the same direction.

1 20. The method as recited in claim 18, wherein the thickness of the bias layer is less  
2 than about 75% of the thickness of the free layer.

1 21. A method for creating a magnetic head, comprising:  
2 adding leads to a wafer stack having a free layer, a bias layer, and a spacer layer  
3 between the free layer and bias layer, wherein a gap is formed between the  
4 leads;  
5 adding a protective layer to the wafer stack such that the gap is covered, the  
6 protective layer also covering facing end regions of the leads;  
7 removing material from at least one side area of the wafer stack using the  
8 protective layer as a mask, wherein the protective layer includes a resist  
9 undercoat and a second layer of resist above the resist undercoat;

10 applying a developer to the resist undercoat for removing a portion of the resist  
11 undercoat such that opposite ends of the resist undercoat along a plane  
12 parallel to an upper surface of the wafer stack are closer together than  
13 opposite ends of the second layer of resist;  
14 removing the protective layer; and  
15 processing a portion of the bias layer below the gap for reducing a magnetic  
16 moment of the bias layer in the portion of the bias layer below the gap for  
17 forming a sensor in which magnetic moments of end portions of the free  
18 layer are pinned antiparallel to magnetic moments of end portions of the  
19 bias layer.

1 22. The method as recited in claim 21, wherein the magnetic moments of the end  
2 portions of the free layer are pinned antiparallel to the magnetic moments of the  
3 end portions of the bias layer.

1 23. The method as recited in claim 21, wherein the leads are added to the wafer stack  
2 by an additive process.

1 24. The method as recited in claim 21, wherein the gap is formed between the leads  
2 by reactive ion etching.

- 1    25.    The method as recited in claim 21, wherein the material in the at least one side  
2           area of the wafer stack is removed by at least one of ion milling and sputter  
3           etching.
- 1    26.    The method as recited in claim 21, wherein an edge of the at least one side area of  
2           the wafer stack after removing the material is oriented at an acute angle relative to  
3           a line perpendicular to a plane parallel to an upper surface of the wafer stack.
- 1    27.    The method as recited in claim 21, wherein material is removed from both side  
2           areas of the wafer stack, wherein edges of the side areas of the wafer stack after  
3           removing the material taper towards each other in a direction away from the wafer  
4           stack.
- 1    28.    The method as recited in claim 21, wherein the protective layer is removed by a  
2           lift off process.
- 1    29.    The method as recited in claim 21, further comprising adding lead material to the  
2           at least one side area of the wafer stack.
- 1    30.    The method as recited in claim 21, wherein the magnetic moment of the bias layer  
2           is reduced by oxidation.

- 1 31. The method as recited in claim 21, wherein the magnetic moment of the bias layer  
2 is reduced by ion implantation.
- 1 32. The method as recited in claim 21, wherein the magnetic moment of the bias layer  
2 is reduced by milling.
- 1 33. A magnetic head formed by the process of claim 21.
- 1 34. The magnetic head as recited in claim 33, wherein end regions of the leads taper  
2 towards facing ends thereof.
- 1 35. The magnetic head as recited in claim 33, wherein the magnetic head has no hard  
2 bias elements.
- 1 36. The magnetic head as recited in claim 33, wherein a thickness of the bias layer in  
2 a direction perpendicular to a plane parallel to an upper surface of the wafer stack  
3 is less than a thickness of the free layer in the same direction.
- 1 37. The magnetic head as recited in claim 36, wherein the thickness of the bias layer  
2 is less than about 75% of the thickness of the free layer.
- 1 38. A magnetic storage system, comprising:  
2 magnetic media;

- 3 at least one head for reading from and writing to the magnetic media, each head
- 4 having a sensor formed according to the method recited in claim 1;
- 5 a write element coupled to the sensor;
- 6 a slider for supporting the head; and
- 7 a control unit coupled to the head for controlling operation of the head.